ON ARTERIAL EXPANSION

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Such a great deal of experimentation has been published on plethysmographic work that some time ago Leschke[1] attempted to reach some conclusions by submitting the results of all these studies to a statistical treatment. All of this work, however, has been qualitative; the authors have sought to determine whether the volume of the blood at the periphery increased or decreased. We are unable to find any study in which the amount of increase or decrease has been quantitatively studied. Such a quantitative determination is the object of the present study.

A Lehmann plethysmograph was employed to the glass tube of which an arbitrary scale was attached. The volume of the body of the plethysmograph and of each division of the scale was determined. When the subject was placed in the instrument, the water was taken from a large graduated tube. The volume of the arm was thus determined by subtracting the volume of the water used from the total volume of the plethysmograph.

Three series of determinations were made on each of 24 adult subjects. (1) A Stanton sphygmomanometer was placed above the elbow of the arm used. The sac was then inflated until the diastolic pressure was obtained. In this case the veins were closed while the arteries remained open, and hence the blood backed up in the forearm expanding the arteries to the limits of their elasticity. After this determination the sphygmomanometer was removed. (2) The subject was then instructed to hold his breath for as long a time as possible and a second determination was made. (3) The third determination was made during mental work; mental multiplication of a three-digit by a two-digit number being sufficient, in most cases, to keep the subject concentrated for a period of several minutes. At the beginning of each determination, the reading of the height of the column of water in the tube was recorded, as was also the *greatest* extent of change during the experiment.

[1] Leschke, E., Die körperlichen Begleiterscheinungen seelischer Vorgänge, *Arch. f. d. ges. Psychol.*, 21, 1911, 435ff. Die Ergebnisse und die Fehlerquellen der bisherigen Untersuchungen über die körperlichen Begleiterscheinungen seelischer Vorgänge, *ibid.*, 31, 1914, 27ff.

Subject	Volume of Arm in C. C.	Volume Change Diastolic in C. C.	Volume of Change in C. C. Holding Breath	Volume of Change in C. C. Mental Work	% of Change Diastolic	% of Change Holding Breath	% of Change Mental Work
1	708	12.5	0.0	0.0	1.77	0.00	0.00
2	732	7.5	—1.2	—2.5	1.02	0.17	0.34
3	1103	17.5	0.0	0.0	1.59	0.00	0.00
4	840	5.0	—5.0	—1.2	0.60	0.60	0.15
5	845	15.0	—1.2	—1.2	1.77	0.15	0.15
6	808	10.0	0.0	—1.9	1.24	0.00	0.23
7	888	16.2	0.0	1.2	1.83	0.00	0.14
8	1111	8.8	—3.1	0.0	0.79	0.28	0.00
9	1400	17.5	—3.8	—2.5	1.25	0.27	0.18
10	773	5.0	—1.2	—1.2	0.65	0.16	0.16
11	830	21.2	—7.5	—1.2	2.60	0.91	0.15
12	810	11.2	—2.5	—1.2	1.40	0.31	0.16
13	985	45.0	—1.2	2.5	3.17	1.25	0.17
14	782	15.0	1.2	1.2	1.90	0.16	0.16
15	788	12.5	0.0	—1.2	1.60	0.00	0.16
16	908	22.5	—1.2	2.5	2.48	0.14	0.28
17	1022	17.5	—0.6	1.2	1.70	0.06	0.12
18	812	7.5	—0.6	—1.2	0.92	0.01	0.15
19	1045	16.2	—1.2	0.6	1.56	0.12	0.06
20	838	22.5	—2.5	—2.5	2.68	0.29	0.29
21	955	20.0	—2.5	—3.7	2.01	0.25	0.38
22	1030	37.5	10.0	—1.2	2.75	0.67	0.08
23	1078	30.0	—2.5	1.2	2.78	0.23	0.12
24	1142	25.0	2.5	3.7	2.19	0.22	0.03
Ave.	926	17.9	2.2	1.5	1.76	0.26	0.16

The results are found in the accompanying table. In the first column are indicated the subjects by number. In the next column the volume of the arm under normal conditions is recorded. In the next three columns are the volumes of change in c. c. respectively under the conditions of diastolic pressure, of holding the breath, and of mental work. A *minus*-sign indicates a decrease in volume. Inasmuch as the volume of the arm varies considerably for the different subjects, the actual amount of increase or decrease loses in significance when the different subjects are compared. Hence the percentage of change was calculated for the different experimental situations. These values are found in the last three columns of the table. The averages for the values in each column are found in the bottom row.

It will be noticed that the changes under the conditions of diastolic pressure are very much larger, on the average, than those for either mental work or holding the breath. The average for diastolic pressure is 1.76 *per cent.*, the greatest change being 3.17 *per cent.* (Subject 13), the smallest 0.60 *per cent.* (Subject 4). In the case of holding the breath, the average change is 0.26 *per cent.*, the greatest being 1.25 *per cent.* (Subject 13); while for Subjects 1, 3, 6, 7, and 15 no change was noted. For mental work, the average change was 0.16 *per cent.*, the greatest change being 0.38 *per cent.;* while for Subjects 1, 3 and 8 no change was noted. The change for diastolic pressure was greater than that for holding the breath in every case but one (Subject 4) where it was equal but in the negative direction. The change for diastolic pressure was invariably greater than for mental work. In 10 cases the change for holding the breath was greater than for mental work, in 6 cases it was equal, and in 8 cases less.

Summary

(1) This study suggests a method for dealing with volumetric peripheral vascular changes in a quantitative way.

(2) Under our conditions we were unable to get increases in volume of blood in the forearm which approached the limits of elasticity of the vascular system.

(3) The combination of the sphygmomanometer with the plethysmograph appears to give a better determination of arterial elasticity than does the present medical clinical method.